TESTING OF PV IN RELEVANT CONDITIONS (PV-T) in the context of the Dutch Energy Transition

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A very brief history of the Dutch Energy Transition

RECENT ENERGY HISTORY IN NETHERLANDS

September 2013: Energy Agreement

- Bottom-up approach
- 47 organizations (NGO's, governmental bodies, industrial associations, environmental institutes) signed this agreement

Ambitions:

- Reduction of energy usage of 1.5% /year
- Per 2020, a total of 100 PJ (27 TWh) energy savings
- RE production target 14% in 2020 and 16% in 2023
- Employment of + 15,000 FTE



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PARIS CLIMATE AGREEMENT

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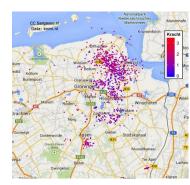
DUTCH EARTHQUAKES DUE TO GAS EXTRACTION





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CLIMATE AGREEMENT PROCESS

Meer dan 100 partijen verlagen de 20,2 Mt 7,3 Mt Elektriciteit 🚘 Mobiliteit CO₂- uitstoot van Nederland met minder CO₂-uitstoot minder CO2-uitstoot 49% ten opzichte van 1990 via het Klimaatakkoord ×. Bedrijfsleven Overheden Maatschappelijke Bedrijfsleven Overheden Maatschappelijke organisaties organisaties Reductie-opgave is 48,7 Mt <u>, O</u>, 14,3 Mt 3,5 Mt Landbouw en á ₽\$ minder CO₂ uitstoot Industrie Maatschappelijke minder CO₂. minder CO₂landgebruik organisaties uitstoot Klimaatberaad ネ ネ ネ Bedriifsleven Overheden Bedrijfsleven Overheden Bedrijfsleven Overheden Maatschappelijke Maatschappelijke organisaties organisaties 3,4 Mt Gebouwde Samenleving minder CO₂-uitstoot omgeving De samenleving doet mee. Meer dan 200 bedrijven en organisaties praten mee, aan tafel * of op een andere manier. Mensen kunnen ook bijeenkomsten in het land bijwonen en zelf Bedrijfsleven Overheden Maatschappelijke organisaties ideeën insturen via de site. **ZOMER'18** ZOMER'18 VA SEPT'18 V.A. JAN '19 曲 PLANNING Afspraken Doorrekenina Uitwerkind Start uitvoerina Klimaatakkoord op hoofdliinen afspraken door PBL afspraken

June 2017: Climate law

Top-down approach

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• Paris \rightarrow EU-goals \rightarrow Dutch goals:

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- 49% less CO2-emissions in 2030 (w.rt.1990)
- 95% less CO2-emissions in 2050 (w.r.t. 1990)
- More than 100 organizations negotiating in structure with 5 tables (see on infographic)
- Implementation throughout a Climate Agreement

CLIMATE AGREEMENT

28th June 2019: Climate Agreement

- 600 concrete agreements
- 4 ministries involved
- Full text available in Dutch and English: <u>www.klimaatakkoord.nl</u>
- Concrete goals for 2030 and for 2050
- Zoom in some targets for 2030:
 - 1.5 million renovated houses (out of the 7 million total stock). Municipalities appoint these houses; deadline 2021
 - 35 TWh/year Renewable Energy production on land
 - 7 TWh/year additional Solar PV attached to buildings (BIPV & BAPV)



HOW MUCH PV SHORT TERM (2030)?

via process of a RES=Regional Energy Strategy with deadlines:

- October 2020: concept-RES
- June 2021: final RES document 1.0

The sum of PV and wind-on-land in all 30 concept-RES agreements is:

- around 50 TWh/year
- of which <u>25 GWp PV is planned</u>

on large roofs and parking areas; this is excluding all residential PV (with a 7 TWh/year target by law)

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WHERE DO WE PUT SUCH A HUGE AMOUNT OF PV IN THE TINY COUNTRY OF THE NETHERLANDS ?





MAP OF THE NETHERLANDS

Land use in the Netherlands, 2012 Red space Houses **Building land** Other built-up area Green space Recreation Agriculture Woodland Nature Blue space Water

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Source: CBS, Land Registry.

CBS/jan16 www.clo.nl/en006110

SCHEMATIC MAP OF THE NETHERLANDS

Agricultural	Forest	Resi-	Indus-	Traf-
20000 km2	3500 km2	dential	trial	fic
		2500 km2	900 km2	
			Other	1200
			900 km2	km2
		Offshore	Inland	d water
	Nature	Nature 4000 km2 400		km2
	1500 km2			
	Recreation	1		
	1000 km2			

Exclusive Economical Zone in the North Sea 57000 km2 Presented in 2018 in roadmap 'PV systems & applications in the Netherlands'

https://www.uu.nl/sites/default/files/roadmap-pv-systemen-en-toepassingen-final.pdf

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- Now, 2 years later, in the Netherlands, there is broad understanding of:
 - Produce (Renewable) Energy close-by the Usage of this Energy
 - Double function of area is mandatory
 - Optimizing only lowest LCOE for the project developer is not the best solution for the country
 - Societal participation needed for a solid support base (not only financial participation)

APPLICATION FIELDS OF SOLAR ENERGY

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Classification into these 4 fields of solar applications is international and widely accepted:

ZON

op **gebouw**

In & On Buildings



• In & On Water



• In the landscape

TU/e and TNO are very active in all 4 national consortia, because innovation is key.

in **landschap**

OUTDOOR LABS



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SOLARBEAT

2013: Kick-off. Official collaboration of TNO(SEAC) with TU/e.

2019: Six years of co-development within 21 projects with 86 companies (63 unique companies).

2020/2021: SolarBEAT moving more towards international projects with larger multinationals showing interest in BIPV.

SOLARBEAT RESEARCH & TESTING

Research topics:

- Building integration
- Electrical integration
- Performance testing as input for system modeling and validation
- Aesthetics

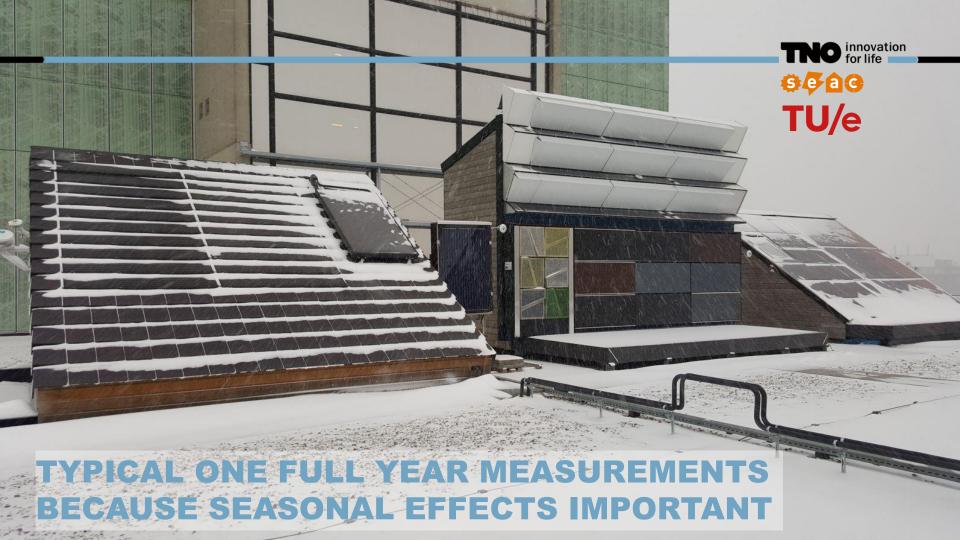
Technologies:

- Solar electricity (PV) all technologies: cSi, CdTe, CIGS, upcoming Perovsikes
- Solar thermal
- Combined (PVT)

Part of building skin:

- Flat roof
- Pitched roof
- Façade: opaque (cladding) and translucent (PV windows or IGU's)
- Balcony



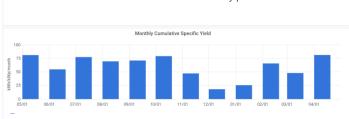


PERFORMANCE TESTING = BIG DATA (?)

SolarBEAT (and other application test fields) active data:

- 40 databases
- 68 dataloggers
- >1500 sensors of
- 55 sensor classes (physics)
- 85 sensor types
- Resolution 1 minute (typical)
- More sampling when needed
- Always according to research plan
- Total: ≈ 2 million datapoints/day
- All synchronized to atomic time

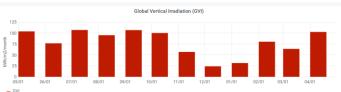
Example:



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IEA PVPS Task 15E Round Robin - dashboard Yearly performance

COLORED BIPV GETTING TO A HIGHER LEVEL



SOLAR THERMAL DETAILS

Solar Thermal (ST):

- Uncovered colored; see next slide
- Covered/Glazed colored; see other slide

Combined (BI)PVT:

- on top of eachother
- ST and PV side-by-side

Thermal system emulation:

- 'Emulation': User pattern as defined by standard is really applied by heatpump inside cabin
- Full year thermal performance testing
- Thermal storage testing

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COLORED SOLAR THERMAL

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EVIL



GLAZED COLORED SOLA

FULL ROOF SOLUTION

THANKS FOR YOUR ATTENTION !

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